



Technology Development and Transfer Office *John C. Stennis Space Center*

VolumeViewer a High-Resolution Volumetric 3D Display System ***A sharp contrast with conventional rendering visualization techniques***



VolumeViewer

A high-resolution volumetric 3D display system, VolumeViewer®, was developed by Genex Technologies, Inc., of Kensington, MD, under a NASA Stennis Space Center Small Business Innovation Research (SBIR) program contract. It has a 360-degree, 3D volume group-viewing capability without the use of any special viewing aids or goggles. The system generates “fish-tank like” volumetric 3D images within a display media that has a physical 3D image. Each volume element, called a voxel, is analogous to a pixel in 2D image. The displayed 3D image locates physically at the x,y,z spatial position and emits light from that position to form real 3D images in the eyes of viewers.

VolumeViewer is a patented volumetric 3D display system that is fundamentally different from conventional 3D visualization technologies. It enables group viewing of a 360-degree, 3D volume display without wearing any special viewing aids or goggles. This provides both physiological and psychological depth cues to human viewers to truthfully perceive 3D objects. The system generates “fish-tank like” volumetric 3D images within a display media that has a physical 3D volume. Each volume element, called a voxel, is analogous to a pixel in a 2D image. The displayed 3D image locates physically at the x,y,z spatial position and emits light from that position to form real 3D images in the eyes of viewers. This is in sharp contrast with conventional rendering visualization techniques where the object is displayed on a 2D flat screen with 3D depth perception.

HOT Points

- **Three-dimensional viewing**
- **360-degree, 3D volume group-viewing capability**
- **High-resolution system**
- **Improves efficiency and accuracy**
- **Broad-based applications**
- **Spinoff products include; 3D cameras, 3D digitizer systems, 3D visualization and application software**

By combining the state-of-the-art technologies in Spatial Light Modulator (SLM), high power laser projection and rotating helix screen, Genex achieved a multi-color, large display volume, true lifelike 3D display system with an unprecedented high-resolution of over 10 million voxels in a portable design. The next generation system will display over 40 million voxels. A high-speed, silicon backplane, ferroelectric liquid crystal Spatial Light Modulator employed in the unique SLM/Helix 3D display system acts as an ultra fast image projector under the illumination of high-power, multi-color lasers. A rotating helix serves as a moving screen to display voxels in a true 3D volume.

Controlled by a host computer, a stream of 2D image patterns produced on the SLM is projected onto the rotating helix surface through properly designed optics, forming high-resolution volumetric images in 3D space. This design solves the problem of having a motion control module (a motor) blocking the optical path of image projection. It also offers the flexibility of software controllable sizes of display volume for various visualization applications.

In comparison with the hologram-type of 3D display, the volumetric 3D display provides a true 3D volume as well as a video-rate, dynamic 3D image display capability. One major issue of computer generating holography is the vast computation power required for calculating the hologram corresponding to the 3D image, which makes the technology still far from practical use. Up until now, image resolution has been low and image size and viewing angle were limited to small values. Due to its unique design concept, the VolumeViewer can be easily scaled up to produce even higher resolution and brightness with a larger display volume (256 by 256 by 157 voxels).

WHY VOLUMEVIEWER IS IMPORTANT

The physical world is three-dimensional, yet most existing display systems handle only two-dimensional flat images that lack the depth information. The lack of true volumetric 3D display often jeopardizes the human ability to truthfully visualize high dimensional data or graphics that are frequently encountered in advanced engineering design and space mission planning. Due to the complexity of satellite data analysis and visualization, the ability to provide sharable three-dimensional visualization of mission scenarios would significantly enhance the efficiency and accuracy of decision-making, validation and a collaborative development environment. A true volumetric 3D display device would literally add a new dimension to the advanced human/computer interface.

Currently, there are several various non-volumetric and volumetric 3D display techniques in use. However, the problem shared by these techniques is that although the principles can demonstrate the proof-of-concept prototypes, it is very difficult to scale-up these concepts to actually produce full-color, full-resolution and full-size 3D systems. Other roadblocks include the limited number of voxels that can be displayed, the decrease in brightness with a larger number of voxels, the difficulty in manufacturing and the inherently monochromatic display.

The true 3D display techniques developed under the SBIR have had a profound impact on improving related imaging technologies through enhanced 3D and 360-degree algorithms and visualization. This technology helps enhance both the efficiency and accuracy of multiple dimensional data analysis and visualization.

The purpose of VolumeViewer was to develop a system for NASA that would visualize various types of three-dimensional data collected by satellite sensors. Genex met this need and proved the technology's feasibility through extensive experiments in visualization, data analysis, and manipulation of NASA's geospatial data acquired by various remote sensors, primarily using the 3D Earth mapping data collected by NASA's Space Shuttle Endeavour Radar Topography mission (STRM mission).

Genex anticipates that the immediate impact of this new realm of technology on consumers will be through improved visualization and production capabilities. Commercial users of Genex's 3D Digitizer systems should experience savings of 50 percent or more off of current manufacturing costs while experiencing improved quality. Medical users of Genex's 3D technology should be able to conduct certain research or perform 3D simulations that were previously impossible.

OTHER PRODUCT DEVELOPMENTS

The technological breakthroughs in the development of VolumeViewer have resulted in the release of a line of patented 3D cameras (under the name Rainbow 3D®), 3D digitizer systems (3D EI Digitizer™, 3D Dental Digitizer™), and 3D visualization and application software (3D Surgeon™, 3D Mosaic™, 3D FaceMap™, 3D Enroll™ and 3D Face ID™). Genex has also improved a related 360-degree imaging technology (OmniEye®) using cameras pointed into a mirror to provide a panoramic view.

Improvements to the Rainbow 3D Camera allow it to capture 3D data in less than one second with up to 25 microns of accuracy, to calculate the full 3D model for display in less than 20 seconds and to provide immediate 3D rendering via Genex's software. The 3D digitizers are now able to capture and render a full 360-degree 3D model in less than one minute by combining the 3D cameras with an integrated motion stage. Also, Genex's highly accurate 3D data can now provide accurate 3D measurements in software packages for use in medical and commercial applications. Additionally, OmniEye enhancements now allow it to include different sensors (higher resolution and infrared) as well as integrate with a pan-tilt-zoom (PTZ) camera that can automatically be directed to an area where motion is detected by the OmniEye system.

As for the 3D line of cameras and software, sales have been approximately \$350,000 over the past 12 months. Genex has sold several systems to hospitals, research institutions and private practice clinics for use in plastic surgery or clinical/medical research, such as cleft-palate research study. The company has also recently been selling its new 3D FaceCam™ system into commercial and retail applications. Several units of Genex's 3D EI (Ear Impression) Digitizer systems are being tested by commercial manufacturers of custom-fitting hearing aids for use in streamlining their manufacturing process.

Genex has also developed a suite of 3D facial recognition solutions and is in discussions regarding licensing the technology with market leaders in the area of facial recognition.

OmniEye is currently being field tested by security dealers, and the company is attempting to license the technology to leading manufacturers of security systems. Sales to date have been modest (\$50,000).

Additionally, Genex is in a cross-licensing arrangement involving with a leading manufacturer in the orthodontic market. Under this agreement, Genex is licensing its 3D imaging technology for \$1,500,000 while the orthodontic company licenses to Genex certain aspects of its 3D image processing for the dental application for \$1,500,000. This investment provides Genex with a ready-made market for its intra-oral 3D technology when development is completed in the next two years.

TARGET MARKETS

The VolumeViewer is targeted primarily towards the aerospace community, military operations and the medical industry. The related 3D capture and processing technologies (Rainbow 3D cameras, 3D digitizers, 3D software) target the medical and dental community for research and practice, and the commercial market for rapid prototyping and “mass customization,” applications, such as custom hearing aids, footwear and jewelry/busts/keepsakes. OmniEye and 3D facial recognition solutions are targeted primarily at the security and surveillance industry, military markets and Homeland Defense.

The commercial market for true 3D display systems is sizeable. The market for compatible 2D display was about \$33 Billion per year in 1998 and is continuously growing. The 3D display system will provide a new level of realism and literally add a new dimension to the fast-growing information technology industry.

FUTURE OF VOLUMEVIEWER

At present, the company is pursuing opportunities with several government agencies and commercial entities for the future use of VolumeViewer and other related 3D technologies. NASA has expressed interest in 3D hyper-spectral data visualization for remote viewing. Genex is in ongoing discussions with the Federal Aviation Administration (FAA) about the adoption of the VolumeViewer for the next generation of our air traffic control system. The federal government and military have also shown an interest in several related technologies for security and surveillance and counter-terrorism, namely 3D facial recognition and the OmniEye. Additionally, the company is working with Johns Hopkins University toward the application of VolumeViewer for oncology treatment and pre-operative planning.

While many are investing in enhancements in 2D displays (flat panel, LCD, plasma), 3D displays represent a completely new way of viewing that will bring about a radical change in visualization systems. Since this technology represents a fundamental transformation in the paradigm of visualization (bringing virtual representations much closer to three-dimensional reality), Genex expects it will take some time for this innovative technology to be adopted.

WHY SBIR?

“We are very grateful for the opportunities provided for us by the SBIR program to develop these cutting-edge imaging and display technologies,” said Patrick May, Genex’s Vice President of Sales and Marketing. “It would be very difficult for a company of our size and resources to achieve the significant advances that we have accomplished without this investment by SBIR. In turn, we believe that the U.S. economy and Homeland Defense will experience significant benefits as our solutions are deployed in the commercial, medical, governmental and military sectors.”

SBIR is a highly competitive, multi-phase program that provides small U.S. businesses with federal funds reserved for conducting serious research and development. Phase I is the start-up segment with awards up to \$70,000; if chosen, Phase II awardees are granted up to \$600,000 to conduct research and development for two years. The SBIR Program at Stennis Space Center is managed through the Technology Development and Transfer Office. For more information regarding the NASA Small Business Innovation Research Program, contact the Technology Development and Transfer Office Space Center at (228) 688-1929 or visit our website at <http://technology.ssc.nasa.gov>.

For more information about VolumeViewer or other Genex 3D and 360-degree technologies, go to www.genextech.com or contact Patrick May of Genex Technologies, Inc. directly at (301) 962-6565 ext. 104 or via e-mail at patmay@genextech.com.

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